Darwin and *Diprotodon:* The Wellington Caves Fossils and the Law of Succession

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Fossil evidence from the Wellington Caves of New South Wales contributed to the overthrow of the theory of special creation and promoted the development of Darwinian theory. The law of succession, which notes the close affinities between recently extinct and living species, was first established on the basis of the Wellington Caves fossils. This law provided a powerful argument in favour of evolution and first attracted Darwin's attention to the problem of the origin of species.

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INTRODUCTION

In the early decades of the nineteenth century Australia was sparsely settled and its colonists had little time to devote to scientific investigation. Palaeontological discoveries were rare and the colonists themselves lacked the scientific expertise necessary to interpret their significance. But the Australian fossil evidence provided European biologists with the key to a fundamental law of distribution and contributed to the development of a new theoretical framework, Darwinian evolution.

The exploration of the Wellington Caves of New South Wales in 1830 led to the first major discovery of mammalian fossils in Australia. The caves aroused a great deal of interest and speculation in Europe because they provided the first evidence of past geographic distribution of mammals in Australia, a continent known for its biological peculiarities. The Wellington fossils challenged some of the treasured assumptions of the Scriptural geologists, particularly belief in the universal Deluge, and thus raised uncomfortable doubts regarding the literal truth of the Bible. More significantly, the fact that the recently extinct Australian mammals were marsupials and thus clearly related to the living mammals of Australia led to the formulation of the 'law of the succession of types', a generalization of fundamental importance in the development of evolutionary theory.

Colonist George Ranken first discovered the fossil remains of the Wellington Caves (Lane and Richards, 1963) and brought them to the attention of the Surveyor-General of New South Wales, Thomas Livingstone Mitchell, who conducted further explorations. Mitchell was particularly interested in cave fossils because he wished to show that the diluvial geology of William Buckland applied in Australia as well as in Europe (Foster, 1936). In *Reliquiae Diluvianae* (1824) Buckland had argued that the recent fossilized remains of large extinct mammals in European caves revealed the action of a universal deluge. These inhabitants of the antediluvian world were, he claimed, destroyed by a world-wide flood. Buckland's views, supportive of the literal truth of *Genesis,* were widely adopted in Australia where conservative religious beliefs predominated in scientific circles.

Colonist John Dunmore Lang first announced the Wellington discovery (Lang, 1830), interpreting the fossils in the context of traditional Christian belief as proof of the literal truth of Scripture and evidence of the wisdom and foresight of the Creator. Lang, a Presbyterian clergyman with an amateur interest in geology, was eager to show that the facts of science were not in conflict with the Mosaic account of creation and the Deluge (Lang, 1846, 1951).

He noted that many of the cave animals were extinct or at least were no longer to be found in New South Wales. Lang adopted Buckland's theory, attributing their extinction to natural catastrophe, a catastrophe which did not materially change the external appearance of the country, i.e., a flood.

He concluded:

> While this very interesting discovery supplies us, therefore, with another convincing proof of the reality and universality of the deluge, it supplies us also with a powerful motive of gratitude to Divine providence for that long-forgotten visitation. For if this territory were over-run with such beasts of prey as the antediluvian inhabitants of the cave at Wellington Valley, it would not have been so eligible a place for the residence of man as it actually is. The tiger or hyaena would have been a much more formidable enemy of the Bathurst settler than the despicable native dog, though indeed they would certainly have afforded a much nobler game to the gentlemeu [sic] of the Bathurst Hunt. And if the huge rhinoceros had inhabited the lagoons of Hunter's River, it might have been a much more serious work to displace him than to shoot the pelican or emu. [Lang, 1830]

Just as Lang and other colonists sought to explain the huge fossils in a manner consistent with their Christian beliefs, so the Aborigines explained them within their own frame of reference. The Aborigines of Eastern Australia were very fearful of the bunyip, a legendary aquatic monster inhabiting deep waterholes and roaming the billabongs at night. Confronted with the fossil remains of gigantic animals, Aborigines often identified these as the remains of the bunyip (Barrett, 1946). As one colonist observed:

> It may not be amiss to state that all the Natives throughout these Northern Districts have a tradition relative to a very large animal having at one time existed in the large Creeks & Rivers & by many it is said that such animals now exist & several of the Fossil bones which I have at various times shown to them they have ascribed to them. Whether such animals as those to which they refer be yet living is a matter of doubt, but their fear of them is certainly not the less & their dread of bathing in the very large waterholes is well known — [Isaac, 1845]

J. W. Gregory, Professor of Geology at the University of Melbourne (later at the University of Glasgow), suggested that Aboriginal legends of gigantic monsters might be based upon a knowledge of the living *Diprotodon* (Gregory, 1906, p. 7).

Lang's theory was published in Europe (Lang, 1831) but European biologists were quick to offer an alternative explanation. Examples of the Wellington Caves fossils were sent to Robert Jameson, Professor of Natural History at Edinburgh University, for identification by European experts. Jameson forwarded them to William Clift, Conservator of the Hunterian Museum, who identified the remains of dasyurids, wombats, and kangaroos (Clift, 1831). All the bones belonged to marsupials of the Australian type with one apparent exception. Lang had suggested that a large thigh bone found in the caves belonged to an Irish elk, rhino, or elephant (Lang, 1830). Clift compared it to the thigh of an ox or hippo (Clift, 1831), and William Pentland claimed that it represented the remains of an elephant (Pentland, 1831). From these data, Jameson observed that Australia, like Europe, was formerly populated with gigantic animals which have since become extinct. Moreover, he argued that the cause of extinction was the same in Europe and Australia, but he did not identify this cause as the Biblical flood. Most significantly, he concluded "[t]hat New Holland was, at a former period, distinguished from the other parts of the world, by the same peculiarities in the organization of its animals, which so strikingly characterize it at the present day" (Jameson, 1831).

This conclusion challenged catastrophist theories. Georges Cuvier, of the Muséum d'Histoire Naturelle in Paris, had developed methods of comparative anatomy which had enabled palaeontologists to reconstruct the skeletons of animals from the fragmentary remains preserved in the fossil record. A vast array of fantastic creatures, now extinct, had been revealed for the first time to an astonished public. Cuvier believed that past geological changes had been sudden and violent, thus causing the extinction of whole populations of plants and animals. These had been replaced by new, unrelated species, either by migration or (as many of Cuvier's followers, including Buckland, believed) by a succession of miraculous, divine creations. Catastrophist theory necessarily ruled out evolution because rapid, violent changes did not allow the necessary continuity of generations and because a comparatively limited age of the earth did not allow adequate time for gradual evolutionary change. Cuvier was recognized as the foremost naturalist of his day, and the full weight of his formidable reputation was solidly opposed to evolution (Coleman, 1964). The full significance of the Wellington Caves discoveries was not recognized until after Cuvier's death in 1832.

The fossils raised uncomfortable doubts about catastrophism and special creation. If all the plants and animals of the Tertiary were destroyed by a universal deluge and subsequently replaced by a specially created, entirely new set of plants and animals, why should there be any continuity between existing species and recently extinct species? In fact, from the principle of adaptation of organisms to their environment one would expect that organic changes would accompany drastic changes in the physical environment. The discontinuities of fossil distribution provided Buckland with the major evidence in support of his theory. European caves contained the fossil remains of tropical species like hyaenas and elephants which no longer survived in Europe. Buckland concluded that these animals had been destroyed by a world-wide flood and expected to find evidence of similar discontinuous distribution on other continents.

The Wellington fossils, however, suggested quite the opposite conclusion. Some of the species found in the caves were still living in Australia, and most European scientists were struck with the similarities between the extinct and living species rather than with the differences. Pentland, for example, observed:

> with a single exception, all the genera to which these fossils are referable, are now found inhabiting the Australasian Continent, a remarkable coincidence with the fossil animals of the same geological epoch in Europe, where, with few exceptions, the animals which have been found in what have been called Diluvial Deposits, belong to genera still inhabiting our countries. [Pentland, 1832]

This fact was taken to cast doubt on Buckland's diluvialist theories. In 1833 Mitchell wrote to George Ranken concerning the significance of their discovery at Wellington:

> I understand Buckland's nose is put completely out of joint by the bones from Australia, their not being those of lions and hyenas is, I find, a fact which is considered in England to entirely upset his theory. And I have now heard from the best authority that the fact of their fossil bones belonging to animals similar to those now existing has worked a great change in all their learned speculating on such subjects at home. [Ranken, 1916, p. 29]

The discovery that the peculiarities of the living Australian flora and fauna were reflected in the fossil species as well suggested that the laws of geographic distribution which currently confine particular groups of animals within particular geographic regions applied in the recent geologic past as well.

The Wellington discoveries, coupled with Darwin's observations in South America, led him to formulate the law of the succession of types. This law provided important evidence in favour of evolution and, indeed, turned Darwin's attention towards the problem of the origin of species (De Beer, 1968, pp. 79-80; Eiseley, 1961, pp. 161-166; Himmelfarb, 1962, pp. 108-113).

Darwin is credited with developing the law in 1837 as a result of his fossil discoveries in South America. Finding the remains of giant mammals related to sloths, llamas and armadilloes, he noted that these extinct mammals are now represented by smaller animals, also confined to South America, which display the same peculiarities of anatomy as their larger predecessors (C. Darwin, 1838). Subsequently, Darwin (1839, pp. 209-210) wrote:

> The most important result of this discovery, is the confirmation of the law that existing animals have a close relationship in form with extinct species . . . The law of the succession of types, although subject to some remarkable exceptions, must possess the highest interest to every philosophical naturalist, and was first clearly observed in regard to Australia, where fossil remains of a large and extinct species of Kangaroo and other marsupial animals were discovered buried in a cave. In America the most marked change among the mammalia has been the loss of several species of Mastodon, of an elephant, and of the horse . . . If Buffon had known of these gigantic armadilloes, llamas, great rodents, and lost pachydermata, he would have said with a greater semblance of truth, that the creative force in America had lost its vigour, rather than that it had never possessed such powers.

Contemplating the Wellington fossils, Thomas Mitchell offered a similar suggestion with regard to the waning power of Australian nature:

> It is consolatory here to find that Australia did once support herbivorous animals of such magnitude — and that an animal so well provided for a country of burning woods and fallen timber — by its young = [sic] protecting pouch and saltatory powers has always belonged to Australia — although the curious gradation of species — and the diminutive character of existing classes seem to indicate the energies of animal nature here to be on the wane — unless indeed this is a wise provision of providence for the introduction of those other large animals by man's agency — which have been found better suited to his wants. [Mitchell, 1843]

The influence of the Australian fossils on the development of the law of the succession of types has not been generally emphasized. Historians have tended to stress instead the importance of Darwin's own South American experiences. Darwin himself, as he tried to reconstruct the development of his ideas in retrospect, recalled the importance of the South American observations. He wrote in his Journal:

> In July [1837] opened first note book on "Transmutation of Species" — Had been greatly struck from about Month of previous March on character of S. American fossils — & species on Galapagos Archipelago. These facts origin (especially latter) of all my views. [C. Darwin, 1959, p. 7]

However, as historian Camille Limoges points out, it is doubtful if Darwin could have developed a comprehensive generalization on the basis of a single South American example (Limoges, 1970, pp. 17-18). The significance of the discovery is unclear until one recognizes that it is true for other parts of the world as well. In fact, Darwin himself cited Clift's work on the Wellington fossils as evidence for the law of succession (C. Darwin, 1859, p. 339). Clift's work was also cited favourably in Lyell's *Principles of Geology* (Lyell, 1833, p. 144), which Darwin had studied while on the *Beagle*. In 1831 E. W. Brayley suggested the possibility of such a correlation in distribution (Brayley, 1831), but the Wellington Caves provided the first and most dramatic evidence for the law.

In 1844 Richard Owen developed a similar law, again based on the Wellington find. Owen, Britain's leading comparative anatomist and palaeontologist, was intensely interested in Australian natural history and developed an extensive correspondence with observers in Australia (Moyal, 1976). Owen classified the vertebrate fossils Darwin had collected on the voyage of the Beagle (C. Darwin, 1840) and provided a description of the Wellington fossils for Mitchell's *Three Expeditions into the interior of Eastern Australia* (Mitchell, 1838). Owen cited the Australian fossils as evidence

> that, with extinct as with existing Mammalia, particular forms were assigned to particular provinces, and, what is still more interesting and suggestive, that *the same forms were restricted to the same provinces at a former geological period as they are at the present day*. [Owen, 1845]

This generalization was frequently repeated in Owen's publications and, together with his work on Darwin's 'Beagle' fossils, formed the basis of his claim to priority in formulating the law of succession. Although Darwin readily acknowledged that Owen had extended the law to apply to the Old World, Owen's attempt to claim credit for the law irritated him. In a letter to Lyell in 1859, he complained:

> Why I gave [in the *Origin*] in some detail references to my own work is that Owen (not the first occasion with respect to myself and others) quietly ignores my having ever generalised on the subject, and makes a great fuss on more than one occasion at having discovered the law of succession . . . Long before Owen published I had in MS. worked out the succession of types in the Old World . . . [F. Darwin and Seward, 1903, I, p. 133]

As further research provided additional evidence for the law of succession, it became an accepted rule of geographic distribution. The close relationship between existing species and recently extinct species strongly suggested an evolutionary connection. Such a connection was, of course, denied by the anti-evolutionists, but they could offer no satisfactory alternative explanation.

Although the discovery at Wellington Caves led to the formulation of the law of succession, it also offered a major exception to it, the alleged Australian elephant. Naturalists wished to show a close affinity between existing species and recently extinct species. Reports of a large Australian placental violated this rule.

Thomas Mitchell had already questioned the identification. He wrote to Ranken in 1831, 'They find most of them [the Wellington Caves fossils] to be wombats and kangaroos, but Cuvier calls your large bone an elephant's. The London surgeons, however, seemed puzzled about it, and I have doubts . . .' (Ranken, 1916, p. 25).

In 1838 Owen resolved the problem by identifying the large Wellington fossil as a new species, *Diprotodon optatum,* a giant, wombat-like marsupial (Mitchell, 1838, 1, p. xix; 2, pp. 362-363). But this was not the end of claims that proboscideans once roamed the Australian bush. In 1843 Owen identified a fossil from the Darling Downs as a *Dinotherium,* an extinct placental pachyderm (Owen, 1843a, 1843b). The following year he corrected this error, noting that some of these bones, too, belonged to *Diprotodon*. At the same time, however, he identified a fossil tooth, ostensibly from Australia, as that of a *Mastodon* (Owen, 1844). This tooth, which the Polish explorer Strzelecki claimed to have acquired from an Australian Aborigine, served as the basis for later accounts of mastodons in Australia. These false identifications and conflicting reports caused a great deal of confusion. Explorer Ludwig Leichhardt (1855) questioned whether there was sufficient evidence to prove this dramatic exception to a well-established rule of geographic distribution. Nevertheless, in Europe, as in Australia, the former existence of an Australian placental pachyderm was generally accepted.

For evolutionists, it was important to get the mastodon out of Australia. Darwinists wished to explain the unique character of the Australian fauna as a result of isolation and natural selection. They claimed that Australia had at an early geological period become separated from the rest of the world by vast oceans. Marsupials, isolated from competition with placentals, evolved to fill a variety of ecological niches. One might account for the presence of placental rodents by Darwin's mechanisms of chance dispersal but these were hardly sufficient to account for the migration of the huge mastodons.

The Australian mastodon remained an anomaly until 1863 when the British palaeontologist Hugh Falconer challenged its existence. Falconer agreed that Strzelecki's tooth belonged to a mastodon, but noted that it appeared to belong to a South American species. Since claims for the existence of mastodons in Australia rested solely on this isolated example, Falconer concluded there must be an error respecting the origin of the fossil (Falconer, 1863). Owen quietly abandoned his

claim. Darwin rejoiced in the overthrow of the mastodon, writing to Falconer in November, 1862, 'I never did or could believe in him' (F. Darwin and Seward, 1903, I, p. 211). In 1882, Owen made one final attempt to revive the Australian proboscidean (Owen, 1882), but he was unsuccessful.

The law of succession, once firmly established, provided a powerful argument in favour of evolution. If one adopts the theory that new species develop from preexisting ones by a process of descent with modification, then it is absolutely necessary that there be a continuity between existing species and recently extinct species. Moreover, the opposing theories of the anti-evolutionists failed to explain this continuity.

The special creationists emphasized the perfect adaptation of animals to their environment, and they attributed this adaptation to God's benevolent design. Yet, as Darwin pointed out, such theories were insufficient to account for the South American and Australian observations. He noted that the animals of Australia are very different from those of South America, even though parts of each continent share a similar climate. Therefore, one could not account for the dissimilarities between South American and Australian animals solely on the basis of adaptation to different environments. At the same time, one could not explain the similarities between living and recently extinct animals on the same continent solely as a result of adaptation to similar environments, because geological change should presumably be accompanied by organic change. Darwin claimed that only a theory of evolution could adequately explain these facts:

> On the theory of descent with modification, the great law of the long enduring, but not immutable, succession of the same types within the same areas, is at once explained; for the inhabitants of each quarter of the world will obviously tend to leave in that quarter, during the next succeeding period of time, closely allied though in some degree modified descendants. If the inhabitants of one continent formerly differed greatly from those of another continent, so will their modified descendants still differ in nearly the same manner and degree. [C. Darwin, 1859, p. 340)

The law of succession not only provided important evidence in support of evolution, it also played a role in convincing Darwin of the validity of evolution. He wrote to Lyell in 1859, 'In fact, this law, with the Galapagos distribution, first turned my mind on the origin of species' (F. Darwin and Seward, 1903, I, p. 133).

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*The ascription to William Pentland is almost certainly an error given currency by Robert Jameson, editor of the *Edinburgh New Philosophical Journal.* W. A. S. Sarjeant and J. B. Delair (*Bull. Brit. Mus. (Nat. Hist.)* , hist. series, 6(7), 1980, p. 319) assign the work to Joseph Barclay Pentland [1797-1873]. *Note added by T. G. Vallance.*